μChemLab™: Bio Detector

A hand-held instrument for bio analysis

Fact Sheet

Sandia National Laboratories is developing a portable, hand-held protein analysis system for multiple homeland security, defense, environmental, and medical applications.

The μChemLab™ system uses fabricated microchannels for performing chemical separations with high sensitivity and rapid response in a compact, low power device. Many different separations can be run simultaneously, and identification of the compound of interest is determined from its unique pattern of retention times.

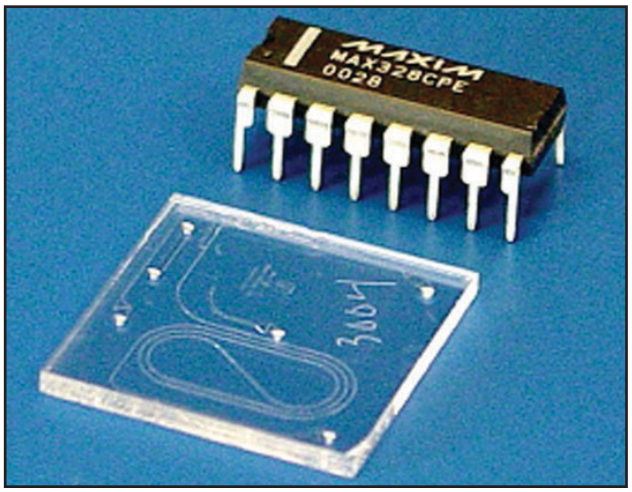
Protein biotoxin detection

Designed for the rapid detection of proteins, the current laboratory demonstration unit has been used to identify biotoxins such as ricin, staphylococcal enterotoxin B, and botulinum toxin; its capability is now being extended to enable identification of viruses and bacteria using protein signatures. Parallel analysis channels provide highly accurate detection at nanomolar sensitivities.

Second-generation biotoxin detection system

Microfluidic separations

μChemLab miniaturizes bench-scale analytical systems in a 100-cubic inch instrument that consumes only 4 watts of power.



Microchannels etched in fused silica chip

The analyses take place in 10-centimeter-long sealed microchannels that are chemically etched in 1-inch-square glass chips. Electric fields are used to manipulate nanoliter volumes of fluids in the microchannels. Components of the sample are sorted for identification as they move through the channel under the influence of an electric field. The length of time a compound is retained in the channel reveals its identity; the chemical separations depend on the interactions of compound with materials in the channel. Sandia has developed novel materials for this purpose with controlled porosity and tailored surface chemistry.

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μChemLab™

The unique chip design allows protein samples tagged with a fluorescent dye to be pressure injected directly onto the chip with no sample carryover. Separations are complete in less than 10 minutes. A miniature blue diode detects labeled proteins through laser-induced fluorescence at low nanomolar concentrations. A preconcentration approach invented at Oak Ridge National Laboratory has been demonstrated to enhance sensitivity 100-fold. On-board data processing can either identify target proteins in real time, or send the data to a computer.

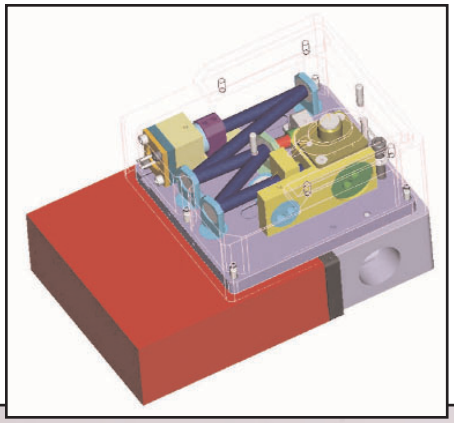
Systems integration and engineering

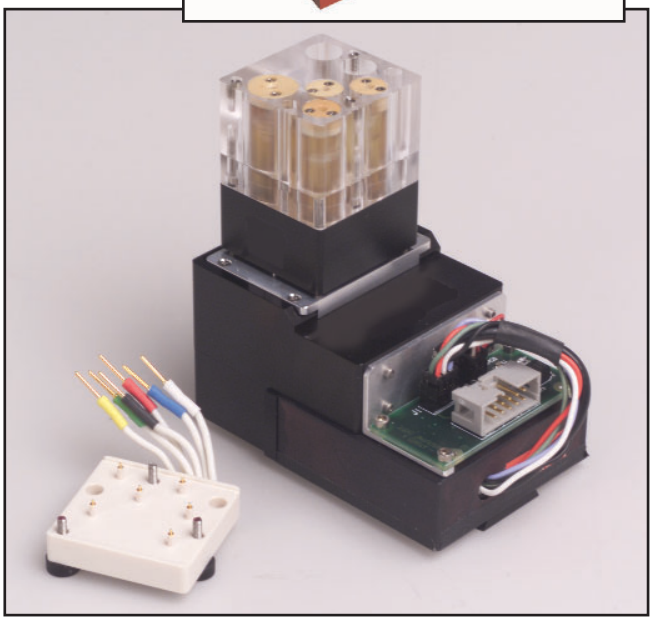
Sandia has successfully miniaturized high-voltage (5 kV) power supplies and control systems to produce controllable electrokinetic flows in a portable device. Fluid-handling hardware provides low dead-volume interfaces for sample introduction and liquid-tight fluidic connections to the buffer reservoirs that allow for rapid replacement of the fluidic chip, injector, and buffer solutions. Electrokinetic flows can be used for on-chip sample preparation such as mixing of reagents, high pressure generation, and packed-bed chromatography. Sandia has also successfully demonstrated the first truly microscale high-pressure liquid chromatography (HPLC) system.

The integration of microseparations-based analysis systems into devices that are rugged, compact, portable, up-gradable, and tailored for the end user is key to the success of this program. Sandia has used expertise in systems engineering to produce research prototypes that will be evaluated for their ability to meet all product design goals.

Status

Portable, stand-alone devices for the analysis of biotoxins have been developed and tested at the research prototype stage. Current research is focused on improving the performance and expanding the capability of these and related devices.





Top: Model of Sandia developed laser-induced fluorescence detector

Bottom: Microfluids are manipulated using high-voltage control.

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